

Remarks

Acceptance/formal entry therefor of this Amendment which, applicants submit, renders the application allowable is respectfully requested. Supportive discussion/rebuttal arguments directed thereto follows.

With the above amendments, claims 1-17, 37, 39, 41-45, 47 and 49-58 remain in this application. Claims 18-36, 38, 40, 46 and 48 are now canceled.

With regard to the claimed subject matter, each of the independent claims was amended in a manner which, it is submitted, is clearly defining even over the combined teachings of the art documents, as applied in the outstanding rejection. In that regard, the invention now calls for, among the featured aspects thereof, a method of manufacture which features cleaning of the surface of the insulating film (e.g., 23, 33) after selectively depositing of the metal (e.g., 26c, 35c) in the formation of a "cap conductive film" as well as prior to selectively depositing of that metal. The present inventors have found that the reliability of the wiring that is formed (e.g., Cu) is improved by cleaning the surface of the insulating film associated with such wiring (e.g., 23, 33) after selectively depositing the cap conductive film as well as prior to selectively depositing of that metal film.

As shown in connection with the 7th example embodiment of the original disclosure, such as discussed in paragraphs [0182] - [0190], covering pages 44-45 of the Substitute Specification, after the selective or preferential growth of the tungsten film (e.g., cap conductive films 26c, 35c) on the grooved wiring (e.g., 26, 35), a cleaning step is added in the process, namely, the surface of the insulating film (e.g., 23, 33) is cleaned such as with a cleaning solution to enhance the reliability of the wiring (e.g., Cu). This featured aspect is now contained with regard to each of the independent claims 1-5, 39, 43, 47, 49 and 58.

As can be seen from the discussion related to paragraphs [0182] - [0190] of the Substitute Specification and from Figs. 27(a) - 27(c), when the substrate surface is cleaned with at least one of a hydrogen fluoride (HF) solution, a hydrogen peroxide (H_2O_2) solution, a citric acid solution and the like after the selective growth of the, for example, tungsten films which are used in the formation of cap conductive films of the wirings (e.g., 26c, 35c), a tungsten film is grown, for example, on the [interlayer insulating] silicon oxide film, which leads to occurrence of selectivity breakdown, such as shown in Fig. 27(a). If the tungsten film is grown on a contaminant metal on the silicon oxide film, there results in an unnecessary tungsten film and contaminant metal causing a lowering of the reliability of the copper wiring. Therefore, applicants have found that by also cleaning the surface of the insulating film where the cap conductive film is formed, the reliability of the copper wiring is further improved. Such a scheme as that now called for is not only a clear and patentable improvement over that previously known but, moreover, could not have been realized even in view of the combined teachings, as applied in the outstanding rejection.

In the Final Office Action, claims 1-17, 37 and 39-58 were rejected under 35 USC §103(a) over the combination of Uozumi (US 6,261,953) in view of Omura (US 6,028,362), Berman (US 5,893,756) and Maeda (JP 11-01696). It will be shown, hereinbelow, the invention according to the claims as currently amended could not have been rendered obvious over the combined teachings of these references. Therefore, insofar as applicable, this rejection is traversed and reconsideration and withdrawal of the same is respectfully requested.

Uozumi disclosed a manufacturing scheme featuring the formation of a barrier metal layer 4 on the surface of a copper (Cu) film 3 by polishing (by CMP) the barrier

metal 4. As can be seen from the discussion in column 7, lines 45-50, and as shown in Figs. 1C and 1D in Uozumi, polishing process (CMP) is employed to bury the barrier metal layer 4 in the upper portion of the wiring groove (see Fig. 1D). Uozumi, it is submitted, did not describe a scheme in which a barrier metal is formed on a Cu film by selective CVD and, also, the cleaning of the surface of the insulating film (e.g., 1) and Cu film. According to Uozumi's method, the copper oxide film 5 is etched without roughening the copper surface by adjusting the solution mixture of aqueous ammonia and aqueous hydrogen peroxide so as to achieve a high enough PH factor. As such, there is formed a wiring groove on the upper portion of the copper layer 3. Also, polishing of the barrier metal layer 4 is effected to bury the barrier metal 4 in the wiring group on the upper portion of the copper layer 3. That is, there is neither discussion nor suggestion by Uozumi of forming the barrier metal on a Cu film by a selective CVD scheme and cleaning of the surface of the insulating film and the copper film.

Omura disclosed a method which includes forming also cap layers (e.g., 60d, 60s) on respective interconnect grooves (e.g., 44S, 44D). As disclosed by Omura, the method therein calls for forming the cap layers 60s, 60d on the surface of wiring material layer 56 by polishing (by CMP) the conductive layer 60. That is, as it relates to the process shown in connection with Figs. 15 and 16, the conductive layer 60 is partially removed to planarize the surface so as to result in the first and second cap layer portions 60s and 60d in the interconnect grooves 44S and 44D, respectively. The CMP process stops when the flat portion of the insulating film is exposed. (Column 13, line 66, to column 15, line 20, in Figs. 15 and 16 in Omura.) That is, the cap layers such as the first and second portions 60s, 60d in Omura, it is submitted, are not selectively grown only in the interconnect layer, as is called for in

independent claims 1-5, 39, 43, 47, 49 and 58. Moreover, Omura did not disclose or suggest forming the cap layers 60s, 60d on the wiring material layer 56 by selective CVD method nor call for cleaning the surface of the insulating film 44 and the wiring material layer 56.

Maeda disclosed a scheme which featured the manufacture of a cap layer (e.g., tungsten layer 11b). In accordance with Maeda's method, the cap layer is formed to be in self-alignment with the Cu wiring layer 4 such as shown with regard to embodiment 2, in Fig. 3 of Maeda. In accordance with Maeda's scheme, it calls for forming the groove wiring 5 into a hole (through-hole) 6 by a polishing process, the polishing process (CMP) removing both the metal barrier layer 3 and the wiring layer (e.g., Cu 4) from outside of the interconnect groove 2. It is submitted, however, Maeda's method is deficient in terms of providing treatment (cleaning processes) subsequent to removal of the portion of the barrier metal layer 3 and wiring layer 4 outside of the interconnect groove 2 and, for that matter, also after the formation of the cap layer (e.g., 11b).

Berman taught a "post metal CMP cleaning processes" for removing a contaminated dielectric layer such as layer 30 of Fig. 1B thereof. (Column 5, lines 1-10, in Fig. 3 in Berman.) However, Berman's disclosure is directed to removal of contaminants that are caused by the slurry employed during the CMP process. (Column 4, lines 22-30, in Berman.) Berman, it is submitted, neither disclosed nor suggested a scheme calling for the formation of tungsten contact plug by selective growth, which is a requirement with regard to the formation of the cap conductive film according to the present invention. Although Berman taught the need for cleaning subsequently to the CMP step, there is neither disclosure nor suggestion by Berman of the need for cleaning after, for example, the selective growth step associated with

the formation of the "cap conductive film", as that presently called for in each of the independent claims 1-5, 39, 43, 47, 49 and 58 and as further limited in the corresponding dependent claims.

Based on the teachings of the above-referred to four (4) cited references, in the outstanding rejection, it is evident that the invention called for in each of the independent claims and as further defined according to the dependent claims thereof could not have been suggested therefrom. From the individual and combined teachings of these references, the following steps, insofar as applicable to the present claimed subject matter could, arguably, be considered as realizable therefrom:

- (i) polishing with a CMP a conductive film to be removed from outside a groove (from Uozumi, Omura and Berman);
- (ii) cleaning the surface of the conductive film in the inside of the groove and insulating films (from Berman); and
- (iii) forming a cap layer on a conductive film by selective growth (from Maeda).

Assuming steps (i), (ii) and (iii) are realizable in view of the combined teachings of the four cited references, their combination is still deficient at least with regard to the cleaning process after step (iii), above. Such, it is submitted, is called for in connection with each of the now pending independent claims.

It is also noted that only Maeda appears to have taught a scheme in which the cap layer is formed on the conductive film by selective growth. Uozumi and Omura, on the other hand, formed a cap layer on the conductive film by CMP and from Berman's teachings, the contaminants on the insulating layer that are caused by the slurry employed during the CMP would be subsequently cleaned. Combining such

teachings, it is submitted, would still not have led to achieving the method of manufacture called for according to the present invention. As mentioned earlier, any such combination involving Uozumi, Omura and Berman, it is submitted, would not have led to forming, also, the cap layer by selective growth, as that presently called for. If, however, Maeda's teachings were to have been combined with Uozumi, Omura and Berman, for purposes of effecting a cap layer by selective growth, the additional cleaning process that would be required subsequently thereto would still not have been realizable therefrom. For these and other reasons, the invention as called for in each of independent claims 1-5, 39, 43, 47, 49 and 58 and further according to the corresponding dependent claims thereof could not have been rendered obvious even over the combined teachings of Uozumi, Omura, Maeda and Berman.

Therefore, in view of the amendments presented hereinabove, together with these accompanying remarks, reconsideration and withdrawal of the outstanding rejection and favorable action therefor on all of the presently claims and an early formal Notification of Allowability of the above-identified application is respectfully requested.

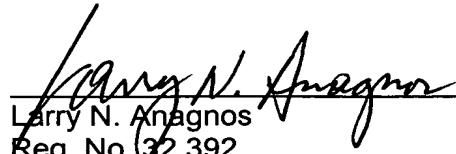
If the Examiner deems that questions and/or issues still remain which would prevent the present application from being allowed at the present time, he is urgently invited to telephone the undersigned representative, at the number indicated below, so that either a telephone or personal interview may be arranged at the Examiner's convenience in order to discuss the same and hopefully resolve any remaining questions/issues present.

To the extent necessary, applicants petition for an extension of time under 37 CFR §1.136. Please charge any shortage in the fees due in connection with the

S.N. 09/850,162

filing of this paper, including extension of time fees, to the Deposit Account of Antonelli, Terry, Stout & Kraus, LLP, Dep. Acct. No. 01-2135 (501.39868X00), and please credit any excess fees to such deposit account.

Respectfully submitted,
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